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GB 2251457 A GB 0412781 A

(58) Field of Search
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ONLINE DATABASES : WPI

(54) Engine with variable compression ratio

(57) In a variable compression ratio internal combustion engine each piston 12 is connected to a crank pin on the crankshaft by means of a connecting rod that is formed in two parts. The first part 10 is rotatably secured to the crank and the second part is rotatably secured to a gudgeon pin 14 of the piston 12. The two parts are connected to one another by a coupling including two eccentrics 26, 28 having axes of eccentricity that are inclined to one another so that the eccentrics cannot both lie in a dead centre position at the same time.

The second part comprises two pairs of links 20, 22, 20', 22' disposed symmetrically about the connecting rod 10. All four links pivot about gudgeon pin 14. The links in each pair may be bonded to each other by elastomeric material 24.

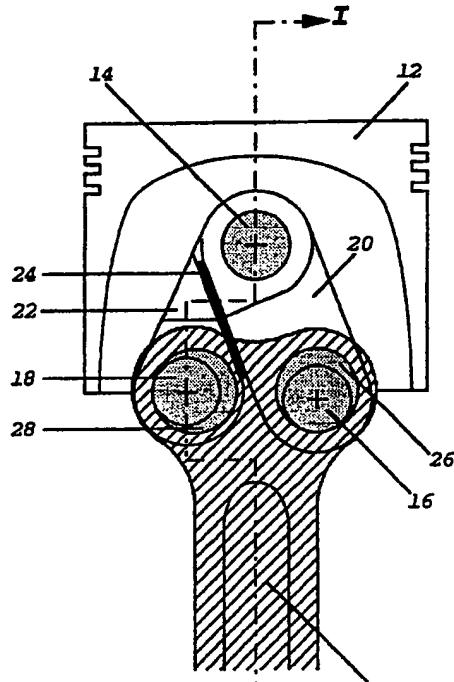
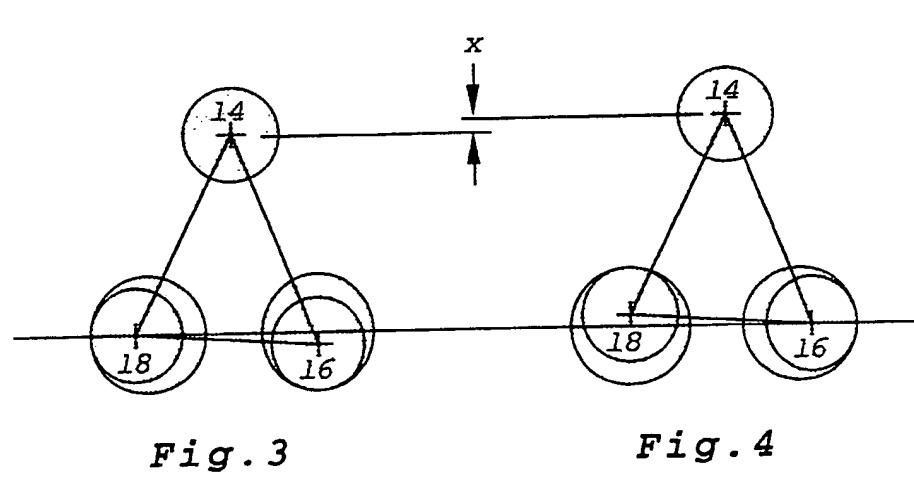
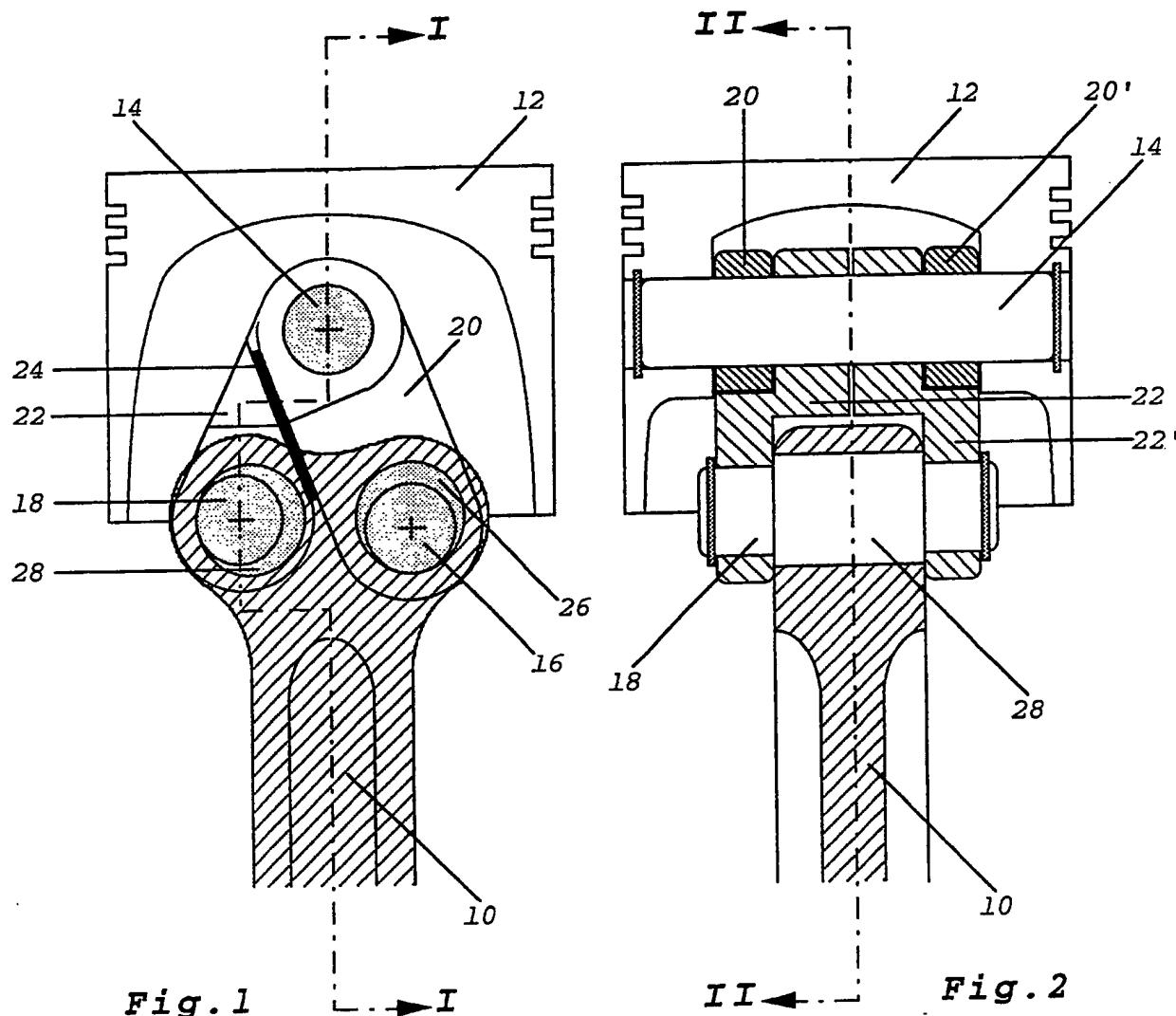


Fig. 1

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ENGINE WITH VARIABLE COMPRESSION RATIO

Field of the invention

5 The present invention relates to an engine with a variable compression ratio.

Background of the invention

10 It is known to vary the compression ratio of an engine by varying the effective length of the rod connecting each piston to a crank pin on the crank shaft or by varying the height of the piston crown. One earlier proposal has been to use an eccentric sleeve interposed at the so-called small 15 end between the gudgeon pin of the piston and the connecting rod. With the eccentric aligned at right angles to the connecting rod, the length of the rod is at its mean value and could be increased or decreased by rotating the eccentric in the appropriate direction towards the top or 20 bottom dead centre positions, respectively.

Though the forces acting on the eccentric as a result of piston inertia and the pressures in the combustion chamber tend to move the eccentric automatically in the desired 25 directions during each operating cycle, there is a risk that if the eccentric reaches a top or bottom dead centre position then no torque is ever developed to dislodge it from this position and the system locks up in a maximum or minimum compression ratio position. Even near these end 30 positions, the torque may not be able to overcome the frictional forces on the eccentric.

To mitigate these problems, it was proposed in WO92/12337 to use a spring biassing the small end of the connecting rod at 35 right angles to its length to centre the eccentric in its mean position but a very strong spring is required to be able to resist the full pressure and inertial loads on the

connecting rod and for this reason the proposal did not prove practicable. Natural oscillation of the spring also risked interfering with the movements of the eccentric.

5 Object of the invention

The present invention therefore seeks to provide an engine that uses an eccentric to vary the effective length of the connecting rod that does not rely on springs to avoid locking up of the eccentric in dead centre positions.

Summary of the invention

According to the present invention, there is provided a variable compression ratio internal combustion engine wherein each piston is connected to a crank pin on the crankshaft by means of a connecting rod that is formed in two parts, the first part rotatably secured to the crank and the second part rotatably secured to a gudgeon pin of the piston, wherein the two parts are connected to one another by coupling means including two eccentrics having axes of eccentricity that are inclined to one another so that the eccentrics cannot both lie in a dead centre position at the same time.

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The term "axis of eccentricity" is used to describe the line that passes through the two centres of rotation of an eccentric which may also be considered as the crank throw or the line of maximum offset.

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Because the two eccentrics can never both lie in a dead centre position, one can now allow one of the eccentrics to reach the dead centre position thereby enabling direct transmission of the load while relying on the other eccentric to move the coupling out of that position and prevent locking up of the coupling when the load is reversed.

Preferably, the axes of eccentricity of the two eccentrics lie at right angles to one another, one being moved into its dead centre position by compression in the connecting rod and the other being moved into its dead centre position by 5 tension in the connecting rod.

Advantageously, the part of the connecting rod rotatable about the gudgeon pin is formed of two pairs of links, each pair lying on a respective side of the connecting rod, the 10 links in each pair each being pivoted about the gudgeon pin at one end and about a respective one of the two eccentrics at the other end, and the links in each pair being resiliently coupled to one another to permit a limited degree of movement of the eccentric towards and away from 15 one another.

Brief description of the drawings

The invention will now be described further, by way of 20 example, with reference to the accompanying drawings, in which:

Figure 1 is a section through a piston and part of a connecting rod assembly of an engine of the invention, the 25 section being taken along the line II-II in Figure 2,

Figure 2 is a section taken along I-I in Figure 1, and

Figures 3 and 4 are schematic diagrams to illustrated the 30 effect of the rotation of the eccentrics on the effective length of the connecting rod.

Detailed description of the preferred embodiment

35 In Figures 1 and 2, a piston 12 is connected to a connecting rod assembly that is formed of connecting rod 10 journaled in the usual way about a crank pin on the engine crankshaft

and coupled to the gudgeon pin 14 at its upper end by means of two pairs of links 20, 22 and 20', 22' disposed symmetrically about the connecting rod 10. All four links in the two pairs pivot about the gudgeon pin 14 that is mounted 5 in the piston 12 and is retained by circlips. The connecting rod 10 has an enlarged head within which there are rotatably received two eccentrics 26 and 28. The eccentrics 26, 28 have eccentric pins 16 and 18 at their opposite ends rotatably received in through bores in the 10 links 20, 20' and 22, 22' respectively. Further circlips hold the links 20, 22, 20' and 22' on the eccentric pins 16 and 18.

Within each pair of links 20, 22 and 20', 22' the links may 15 be pivoted relative to one another in the same way as the jaws of a pair of pliers, the gudgeon pin 14 acting as the pivot point. A layer of elastomeric material 24 is bonded between the facing surfaces of the links in each pair. This elastomeric material holds the two links together during 20 assembly and in operation allows the eccentrics a limited degree of movement towards and away from one another. A small force is exerted on the links by the elastomeric material acting in the direction to separate the eccentrics and the material also serves to suppress noise.

25 As can be seen in Figure 1 when the eccentric pin 16 is in its bottom dead centre position, the eccentric pin 18 lies at 90° to its top dead centre position. The eccentrics 26 and 28 automatically adopt this position when the connecting 30 rod is in compression. This is also the position represented schematically in Figure 3. When the connecting rod is put in tension the eccentric pin 16 will not be subjected to any torque but the eccentric pin 18 will be turned clockwise to move into its top dead centre position 35 shown in Figure 4. The eccentric pin 18 will act directly on the link 22 which in turn will push through the elastomeric material 24 onto to the link 20 and act to

rotate the eccentric pin 16 out of its bottom centre position. The return to the position shown in Figure 3 will likewise occur automatically when the connecting rod is subjected to compression. During this movement, any slight 5 tendency for the eccentric pins to move towards or away from one another is accommodated by contraction or expansion of the elastomeric material 24.

As is clear from Figure 3 the effect of the rotation of the 10 two eccentrics 16, 18 is to move links 20, 22 and thereby vary the effective length of the connecting rod assembly by an amount x as the forces on the connecting rod assembly alternate between tension and compression.

15 In operation, at the end of the compression stroke of the engine the connecting rod 10 is held at one end by the crank pin while the inertial force on the piston acts to place the connecting rod assembly in tension. There is however opposition to this movement from the pressure within the 20 combustion chamber and the net force on the connecting rod will vary with engine speed and load. The lost motion created by the eccentrics 16, 18 will allow the piston 12 to move to the maximum extent possible to reduce the end volume and thereby increase the compression ratio. As soon as the 25 engine fires the combustion pressure will now act to put the connecting rod assembly in compression and immediately the piston will move freely relative to the crank pin due to the effect of the rotation of the eccentrics without transmitting any torque to the crankshaft. Once the 30 eccentric pin 16 reaches its bottom dead centre position the compression forces are then directly transmitted to the crankshaft. The kinetic energy of the piston developed during the rotation of the eccentrics is also at this time transmitted to the crankshaft.

35 The effect on the combustion cycle of such movement of the piston is that compression always reaches a maximum for the

speed and load conditions and expansion always takes place in two stages. The first stage occurs very rapidly which reduces the risk of abnormal combustion due to engine knock. The rapid expansion is also accompanied by immediate
5 reduction of the gas temperature which reduces the formation of NOx. Thermal efficiency is further improved by reduced heat loss resulting from the reduction in gas temperature and the reduction of the surface to volume ratio of the combustion chamber. The second stage of the expansion is
10 the same as that in a conventional engine with fixed compression ratio.

The inertial force on the piston will also always minimise the end volume at the end of the exhaust stroke. Because
15 the exhaust valve is open during the exhaust stroke, there is only the exhaust back pressure opposing the inertial forces during this part of the cycle and the piston will therefore invariably reach the very top of its stroke. Likewise at the end of the intake stroke, the downward
20 inertia of the piston will result in it reaching the very bottom of its stroke. The engine therefore has better scavenging and improved volumetric efficiency and better idling performance on account of the improved combustion stability.

25 It will be appreciated that the connecting rod assembly will undergo extension and contraction cyclically and that the operation described above is a dynamic one that repeats with each engine combustion cycle attempting at all times to
30 maximise the compression ratio for the prevailing speed and load conditions.

It is known that bearings in the small end of the connecting rod can be lubricated either by splash lubrication or by
35 forced lubrication. In the former cases, the oil spray present in the crankcase is relied upon to ensure that the lubricant reaches all the bearing surfaces and in the latter

case oil from the oil pump is directed under pressure to the bearing surfaces through bores in the connecting rod and in the bearing surfaces. The engine construction described above does not preclude either method of lubrication.

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CLAIMS

1. A variable compression ratio internal combustion engine wherein each piston is connected to a crank pin on the 5 crankshaft by means of a connecting rod that is formed in two parts, the first part rotatably secured to the crank and the second part rotatably secured to a gudgeon pin of the piston, wherein the two parts are connected to one another by coupling means including two eccentrics having axes of 10 eccentricity that are inclined to one another so that the eccentrics cannot both lie in a dead centre position at the same time.

2. An internal combustion engine as claimed in claim 1, 15 wherein the axes of eccentricity of the two eccentrics lie at right angles to one another, one being moved into its dead centre position by compression in the connecting rod and the other being moved into its dead centre position by tension in the connecting rod.

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3. An internal combustion engine as claimed in claim 1 or claim 2, wherein the part of the connecting rod rotatable about the gudgeon pin is formed of two pairs of links, each pair lying on a respective side of the connecting rod, the 25 links in each pair each being pivoted about the gudgeon pin at one end and about a respective one of the two eccentrics at the other end, and the links in each pair being resiliently coupled to one another to permit a limited degree of movement of the eccentric towards and away from 30 one another.

4. An internal combustion engine as claimed in claim 3, wherein the links in each pair are bonded to one another through the intermediary of an elastomeric material that 35 acts resiliently on the links in the direction to urge the eccentric away from one another.

5. An internal combustion engine constructed arranged and adapted to operate substantially as herein described with reference to and as illustrated in the accompanying drawings.

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Patents Act 1977
Examiner's report to the Comptroller under Section 17
(The Search report)

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Relevant Technical Fields

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 (ii) Int Cl (Ed.5) F02B, F16J

Search Examiner
 V L C Phillips

Date of completion of Search
 16 September 1994

Databases (see below)

(i) UK Patent Office collections of GB, EP, WO and US patent specifications.

Documents considered relevant following a search in respect of Claims :-
 1-5

(ii) ONLINE DATABASES : WPI

Categories of documents

X:	Document indicating lack of novelty or of inventive step.	P:	Document published on or after the declared priority date but before the filing date of the present application.
Y:	Document indicating lack of inventive step if combined with one or more other documents of the same category.	E:	Patent document published on or after, but with priority date earlier than, the filing date of the present application.
A:	Document indicating technological background and/or state of the art.	&:	Member of the same patent family; corresponding document.

Category	Identity of document and relevant passages			Relevant to claim(s)
A	GB 2251457 A	(FORD)		
A	GB 0412781 A	(VITALBA)		

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